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Then weep not the pleasures so fading and dear,
For the handmaids of bliss in yon starry abode,
Shall wipe from your eyes the disconsolate tear,
And ray on your pathway the smiles of your God.

FOREIGN LITERATURE.

PROCEEDINGS OF THE FRENCH NATIONAL INSTITUTE.

THE class of mathematical and physical sciences has proposed the following prize question:

The first inquiries concerning sound, date very high in antiquity The proportion of the length of strings producing different notes, are said to have been found by Pythagoras; but this branch of science made no remarkable progress before the end of the seventeenth century. Sauveur, a member of the French Academy of Sciences, showed by very ingenious experiments, that the sounding cord was divided into different waves, separated by knots, or points of rest, and he determined the absolute number of vibrations that constitute each note, deduced in the first place from delicate and *curious experiments*, which he compared afterward with the algebraic formulæ derived from the theory of the centres of oscillation; as appears in the memoirs of the Academy, for 1713.

Taylor, in his *Methodus Incrementorum*, published 1717, treated the problem more profoundly on the hypothesis, that the forces acting on the material points of the system are proportional to their distances from a right line drawn from one fixed point to the other, so that these points all arrive at the right line at the same time. Twenty or thirty years after this, Daniel Bernoulli, farther developed the theory of Taylor; but for the general and strict solution of the problem we are indebted to d'Alembert and Euler. These great geometricians first employed the differential equation of the motion of the sonorous chord, which is with partial differences, and of the second order. This equation was first found and summed up by d'Alembert, but Euler was more fully aware of its universality.

An equation of the same order is applicable to the oscillations of air in tubes, and does not change, when from the case of the simple line we proceed to cases of two or three dimensions.

In the problems of which we are speaking the order of the differential equation of the motion is connected with the manner in which we consider the effects of elasticity in the body moved. It has been here applied to a chord stretched between two points. If the chord be let loose at one of these points, and be perfectly flexible, it is incapable of producing any acoustic phenomenon.

It is otherwise if the chord be a spring. In this case, confining it if you please to a single fixed point, the spring set to vibrate will produce a perceptible sound, if its oscillations exceed twenty-four per second; but the differential equation of this movement will be of the fourth order. The first problem may be considered as a particular case of the second, abstracting the spring; but the converse does not hold.

This essential difference between the questions of the movement, considered in each of these points of view, in the case of a simple line, leads us immediately to conceive that we must find differences of the same kind, and also a great increase of difficulties, when we introduce two dimensions into the calculation. The acoustic phenomena produced by parchment stretched, as on a drum-head, are referrible to those of the chord; the phenomena of metallic plates, to those of the spring.

Euler, in his paper *de Motu vibratorio Tympanorum*, has considered the parchment as composed of threads crossing each other at right angles. A geometrician of the Institute has published in one of its volumes some researches into this subject, contemplating it in the same point of view. The differential equation of the motion, which is partial and of the second order, cannot be summed up, at least in finite terms.

In his paper *de Sono Campanarum*, Euler attempts to reduce the vibrations of hard surfaces formed by revolution to those of circular elastic rings, of which he considers them as an assemblage, situate in planes perpendicular to the axis of revolution, and supposing the effects of the vibrations to be a variation of the lengths of their diameters. He here arrives at an equation with partial differences of the fourth order, not summable in finite terms.

This is all that geometricians have hitherto been able to effect with regard to the problems of sonorous bodies, considered in the case of two dimensions, and even introducing simplifications, which, it cannot be denied, alter the natural state of things, so that the results of analysis cannot be applicable.

These hypothetical simplifications are particularly inadmissible in respect to vibrating surfaces of metal, or a substance naturally elastic. In the most simple case, that of a plane, it is obvious that Euler's hypothesis of the vibration of surfaces of revolution does not apply. We have not even the differential equations of the motion for vibrations of this kind, considering their phenomena as nature presents them; and to find these equations would be an interesting subject of meditation to geometricians, which would contribute equally to the advancement of natural philosophy and mathematics.

Happily Mr. Chladni has done for the vibrations of elastic surfaces what Sauveur did a century ago for the stretched chord. He has discovered and rendered perceptible, in a very ingenious manner, by the arrangement dry sand takes on vibrating plates, undulations with points of rest interposed. His majesty the emperor and king, who has seen the experiments of Mr. Chladni, struck with the influence that the discovery of a strictly accurate theory, capable of explaining all the phenomena rendered sensible by these experiments, would have on the progress of natural philosophy and mathematical science has desired the class to make it the subject of a prize, to be proposed to all the learned of Europe. The class accordingly announces it in these terms.

"To give the mathematical theory of the vibrations of elastic surfaces, and compare it with experiments."

The prize will be a gold medal of the value of *3000f.* (*125l.*) to be awarded at the public meeting on the first Monday in January 1812. No work will be received after the 30th of September 1811.

We shall add an abridgment in our next of the report adopted by the class of mathematical and physical sciences, and that of the fine arts, on the 13th of February, and 1 th of March 1809, on Mr. Chladni's work, concerning the theory of sound.

This treatise, published in German, in 1802, and about to be translated into French, contains every thing of importance in his first work, that appeared in 1787, besides considerable additions. Under the title of Acoustics; it is divided into four parts, which treat, 1st, of the numeral ratios of the vibrations of sonorous bodies; 2ndly, of the laws of the phenomena they exhibit; 3dly, of the laws of the propagation of sound; 4thly, of the physiological part of acoustics. The first contains little but what is already known. To determine the absolute number or vibrations in a note however, Mr. Chladni does not employ a chord, but a slip of metal fixed at one extremity, and long enough to allow the oscillations it makes in a given time to be counted. Their number is to that of the vibrations of another slip of metal, taking place in the same time, and under the same circumstances, in the inverse ratio of the squares of their lengths. In this part too, Mr. Chladni treats of the temperaments proposed by different persons. He prefers that adopted by Rameau which renders the twelve semitones included in the octave, perfectly equal to each other, by making them answer to twelve geometrical mean terms, between the two extremes.

In the 2nd part we find the author's discoveries. He first examines the vibrations of chords and rods, and distinguishes three sorts, the transverse, longitudinal, and those which he calls gyratory. The first take place when a chord or rod is struck in a direction perpendicular to its length. But a rod that would produce a certain note when thus struck, would emit a very different one, if rubbed with a piece of cloth in the direction of its length. If the rod be of glass, the cloth must be wet; if of any other substance, dry. These vibrations, which he terms longitudinal, he has found subject to the same laws in a solid rod, as the longitudinal vibrations of the air in an organ-pipe; and he has given a table of these vibrations for different substances, such as glass, metal, and wood.

Notes still different from these emitted in the two preceeding circumstances, are produced, when a rod is rubbed in a direction very oblique to its axis. Mr. Chladni gives the epithet of gyratory to the vibrations resulting from this kind of friction, because he supposes, that the particles of the substances receive a movement of oscillation round its longitudinal axis. He says he has found in these vibrations the numerical ratios are the same as those of the longitudinal vibrations, but that the tones of each rod are a fifth higher.

Each series of inquiries above mentioned, has been made with rods fixed at each end, rods meerly supported at one or both ends, rods fixed at one end and supported at the other, and rods loose at each end. Each of these circumstances occasions a difference in the results. Mr. Chladni has likewise examined the vibrations of curved rods, forks and rings. Euler applied the last species of vibrations to the phenomena of the sound of bells; but Mr. Chladni has shown very justly, that his hypothesis do not accord with nature.

The last two sections of this part are devoted to the vibrations of plates and bells, or plane and curved surfaces in general, a subject wholly new in experimental philosophy; and which, notwithstanding the striking regularity of the phenomena, has resisted the efforts of the able geometricians, who have attempted to treat on it.

Mr. Chladni has ascertained the places, which the tones we may draw from plates, by giving them different forms, and by causing them to sound in different methods, occupy in the musical scale. But these inquiries are particularly interesting when combined with those for determining the portions of each plate that have distinct and co-existing vibrations, and the remarkable curves that form their perimeters. For these experiments the plate, covered with fine dry sand, is to be held between the thumb and one finger, the ends of which press on directly opposite points of the two faces, while a bow is drawn over some point of its edge. Sometimes a third finger is applied at different points of one of the faces, to vary the results of the experiments. The point of support is always in one of the curves of equilibration. The figure of these curves, and their arrangement, depend on the position of the point of support, that of the point to which the bow is applied, and that of the different sounds we wish to produce by rubbing the bow in different ways on the same point. A change in either of these produces a correspondent change in the curves.

While speaking of these curious phenomena, we cannot avoid noticing a paper inserted in the first volume of the Transactions of the Italian Institute, entitled Inquiries concerning the Vibrations of Elastic Plates. The author, Mr. Paradisi, says in a note, that he was led to make his experiments by a passage in the Bibliothéque Britannique, where Mr. Chladni's were described. Having provided an apparatus, by means of which he could keep the plates fixed at any point of their surfaces without the assistance of the fingers, he first perceived, that the curves of equilibration did not arrive at settled figures, till after a gradual and continual succession of variable figures; the generation of which, being examined by him with great attention, led him to new deductions concerning the theory of these curves.

Thus, for example, if we take a rectangular parallelogram of glass, nine inches long, and three broad, fix it in the line of its longer axis, one sixth of its length from the end, and apply the bow to one of the longer sides of the parallelogram, at one third of its length; the lines in the sand, when come to a state of rest, will divide the surface into eight equal rectangles by a right line in the direction of the great axis, and three equidistant right lines parallel to the shorter sides. But Mr. Paradisi found, that on causing the plate to vibrate by a succession of very little touches with the bow, eight semicircles were first obtained, the centres and diameters of which were placed symmetrically on the longer sides of the parallelogram, and the point of application of the bow was one of these centres. These semicircles gradually increase: those on the same side from being separate come into contact, and afterward penetrate into each other, leaving between them rectilinear lines perpendicular to the longer sides; and in proportion as these lines increase in length, the arcs flatten as they approach the greater axis of the parallelogram, with which they are at length confounded.

In other experiments Mr. Paradisi obtained whole initial circles formed on the surface of the plate, and semicircles with their diameters resting both on the longer and shorter sides of the parallelogram. The velocity of the grains of sand placed in the perimeters diminished in proportion, as the radii increased.

Mr. Paradisi applies the term of *centre of vibration* to the centre of the circle that forms round the point to which the bow is applied, and that of *secondary centres* to those of the other circles. Supposing afterward, that, when the system of curves is arrived at a fixed state, any given element of these curves is directed by the result of several forces, the actions of which emanate from these different centres of vibration, and are functions of their distances from the element of the curve in question, he arrives at a differential equation between the co-ordinates of this element, the summation of which would require the form of the functions, that represent the laws of the actions of the forces, to be known. He promises us farther inquiries on this subject in another paper.

We must refer to the memoir itself for his other experiments, among which are some interesting ones on changes in the fixed point, and in the point to which the bow is applied, without producing any in the figure or arrangement of the curves.

To return to Mr. Chladni, his second part concludes with reflections on the vibrations of bells, and of curved surfaces in general, and on the co-existence of vibrations in sonorous bodies. He speaks of the theory and hypothesis of Euler respecting the sound of bells; of Rameau's system of the fundamental base; of the musical system of Tartini, founded on experiments, which according to Mr. Chladni, were known in Germany long before Tartini made use of them, and which may be considered as the inverse of Rameau's; and lastly of the combination, which takes place in certain circumstances, of the vibratory with other kinds of motion.

In the third part the author first considers the propagation of sound as effected by the air and different aeriform fluids: he then examines the cases where it takes place through the intervention of liquid and solid substances. We find the experiments, which the author made in concert with professor Jacquir of Vienna, on the vibrations of various kinds of gas; and conjectures on the cause of the difference between the velocity of the propagation of sound through air, &c. and that given by theory The committee conceive, that the two classes ought to bestow distinguished eulogiums on the discoveries of Mr. Chladni respecting the philosophy of sound; and that it is an object of importance, to direct the attention and emulation of the learned to those physico-mathematical researches, to which his discoveries may give rise.

Signed, de Lacépède. Hauy, Méhal, Gossec, Gretey, Le Breton, de Prony.

Imperial Academy at Petersburgh.

The following prize subject is proposed by this Academy for the year 1810

"To improve the theory of sluices, and thence to deduce rules for constructing these important works in the most advantageous manner; so that they may be used with all possible security and speed, be attended with as little expense as may be for their construction and for keeping them in repair, and incur no waste of the water required for the passage of loaded vessels more than is absolutely necessary."

And for 1811. "To give a complete comparative chronology, and, if possible, corrected and verified, of the Byzantine authors, from the foundation of the city of Constantinople till its conquest by the Turks."

The prize for each is 100 Holland ducats(£46,5),and the answers must be sent before the 1st of July in each year.